N94-14983

CHARACTERIZATION FACILITY FOR MAGNETO-OPTIC MEDIA AND SYSTEMS

M. Mansuripur, H. Fu, S. Gadetsky, S. Sugaya, T.H. Wu, J. Zambuto, R. Gerber, T. Goodman and J.K. Erwin

OBJECTIVES

Objectives of this research are listed below.

Measure the hysteresis loop, Kerr rotation angle, anisotropy energy profile, Hall voltage and magnetoresistance of thin-film magneto-optic media using our loop-tracer. This instrument has a maximum field capability of 21 kOe, and can measure the temperature-dependence of the media's magnetic properties in the range 77 K to 475 K.

Measure the wavelength-dependence of the Kerr rotation angle, θ_k, and ellipticity, ϵ_k, for thin-film media using our magneto-optic Kerr spectrometer (MOKS). The spectrometer operates in the wavelength range 350 nm to 1050 nm.

Measure the dielectric tensor of thin-film and multilayer samples using our variable-angle magneto-optic ellipsometer (VAMOE). This device measures (at the HeNe wavelength of 633 nm) the complex reflection coefficients of the samples at angles of incidence ranging from 26° to 88°. A computer program then estimates the dielectric tensor from the measured coefficients of reflection.

Measure the hysteresis loop, coercivity, remanent magnetization, saturation magnetization, and anisotropy energy constant for thin film magnetic media using vibrating sample magnetometry. The temperature range of our VSM is 77 K to 1000 K, and it has a maximum magnetic field capability of 12 kOe.

Observe small magnetic domains and investigate their interaction with defects using magnetic force microscopy.

Perform static read/write/erase experiments on thin-film magneto-optic media using our static test station. The test station is a polarized-light microscope, modified to include a laser diode, electromagnet, temperature-controlled stage, and a TV camera, all under computer control.

Integrate the existing models of magnetization, magneto-optic effects, coercivity, and anisotropy in an interactive and user-friendly environment. Analyze the characterization data obtained in the various experiments, using this modeling package.

Measure focusing- and tracking-error signals on a static testbed; determine the "feedthrough" for various focusing schemes, investigate the effects of polarization and birefringence, and compare the results with diffraction-based calculations. The testbed has two HeNe lasers (λ_1 = 544 nm, λ_2 = 633 nm), a series of high-NA objectives (0.5 to 0.8), piezoelectric actuators (with better than 0.1 μm positioning accuracy) for driving the sample, CCD camera emulating multi-element detectors, several interchangeable focus-error modules, and in-built shearing and Twyman-Green interferometers for ascertaining beam quality and/or calibrating the focus position.

Measure the birefringence of optical disk substrates using two variable angle ellipsometers. The first system operates at λ = 780 nm and has the capability of both reflection and transmission measurements. The beam in this system has an angle of incidence θ in the range of (0, 70°), and an azimuth of incidence ϕ which can vary continuously from 0 to 360°. The second system operates at λ = 633 nm, is restricted to reflection measurements only, and has an angle of incidence in the range of (20°, 70°). The azimuth of incidence in this system is restricted to two values: 0 and 90°.

PROGRESS

Substrate Birefringence Measurements

A significant fraction of our efforts during the past quarter was devoted to measurements of substrate birefringence. We now have three systems and four people devoted to this project. A complete report on this work appears as Appendix A and soon will be submitted to *Applied Optics*. The following is a brief description of the three systems with emphasis on their main features.

VAE633. This variable-angle ellipsometer operates at the HeNe wavelength of 633 nm, can make reflection measurements only, and is limited in its setting of the azimuth of incidence (ϕ = 0 and ϕ = 90° are the only possibilities). The system originally was built in our laboratory for dielectric tensor measurements for magneto-optic media, and recently was modified for birefringence measurements.

VAE780. This variable-angle ellipsometer operates at λ = 780 nm, has both the reflection and transmission capability, and allows arbitrary settings of the azimuth of incidence (ϕ = 0 - 180°). The system has been designed specifically for measuring birefringence on 3.5 in. and 5.25 in. optical disk substrates.

Commercial ellipsometer. This variable-angle and variable-wavelength ellipsometer was donated to us by Eastman Kodak Company (we thank Dr. Joseph Wrobel of Kodak Research Laboratories for suggesting and facilitating the donation). We have made a minor modification to the system and have begun measuring substrate birefringence at various wavelengths (λ = 400 nm - 800 nm). This work is in the preliminary testing stage and we hope to present its results at the IAB meeting in April.

Ring-Toric Lens for Focus-Error-Detection

Work on the ring-toric lens continued during this quarter. We have fabricated several more lenses and tested them in our static testbed. A report on the progress of this work is included as Appendix B. The upgraded testbed can measure at two wavelengths (red and green HeNe) as well as two polarization directions (parallel and perpendicular to grooves). We have done extensive comparisons between the ring lens scheme of focus error detection and the conventional method of using an astigmatic lens.

Magnetic and Magneto-Optic Characterization of Magneto-Optic Media

Hong Fu has completed a series of studies on thermomagnetic write/erase cycle using the Connection Machine simulations. He will present an invited paper on this subject at the Intermag meeting in Stockholm, April 1993. He is working on a long paper for *Computers in Physics* based on these studies and expects to have the paper ready in time for the next quarterly report.

Sergei Gadetsky, our new research scientist, arrived in December and is engaged in a study of Co/Pd superlattice films produced by Dr. T. Suzuki of IBM Almaden Research Center. His findings are summarized in Appendix C.

PLANS

During our studies of substrate birefringence we have noticed certain curious phenomena related to the relative orientation of incident beam and grooves on the substrate. We plan to look into these phenomena carefully and will try to understand their origins.

The ring-lens studies will continue and we will try to make lenses with smaller ring diameters. We also will investigate the dependence of track-crossing signal and feedthrough on the relative orientation of polarization vector and the groove.

With the graduation of Bruce Bernacki and his departure for Oak Ridge National Laboratory, we will miss one of our highly productive members. New students will be learning to use DIFFRACT and will continue Bernacki's modeling of the optical path in magneto-optic systems.